

REA

INSTRUCTIONS TO BE GIVEN TO PROSPECTIVE INSPECTORS

PRIOR TO EXAMINATION BY A REA REPRESENTATIVE

The National Electrical Code is a collection of rules and regulations governing the installation and to a certain extent, the use of electrical equipment. Its purpose is to reduce the hazard from electrical fires and electrical accidents. It does this by specifying the exact manner in which electrical materials, devices, fittings and appliances be originally installed and later maintained. A strict compliance with the requirements of the National Electrical Code will produce an installation which may be deemed reasonably safe from electrical fires or accidents at the time of its installation and which, with proper maintenance, should remain in a safe condition over a period of years.

The prevention of electrical fires and accidents is of importance from many standpoints. It is quite obvious that to the user of electricity the safety of an electrical installation is of prime importance. It is equally evident that the electrical safety of theaters, schools, churches, stores and factories and other locations where people may gather is also of importance.

Insurance companies, who were the first to develop electrical codes, are directly interested from the standpoint of losses which may result from electrical fires or electrical accidents.

The manufacturer wants to construct his product so that it is safe to use and manufacturers of electrical equipment must conform to Code requirements in the construction of their products. Such manufacturers are interested in seeing that only equipment which meets this standard is used.

- The electrical wholesaler, jobber and dealer have an interest in the National Electrical Code quite similar to that of the manufacturer.

The electrical contractor, who must comply with the Code in his electrical installations, has an intimate and special interest in the Code and its uniform application to all contractors alike and to all territories.

The cooperative's interest in the code lies in its legal and moral responsibility in the safe supply of its current to the consumer member.

The cooperative electrical inspector must have a working knowledge of the Code requirements in addition to an understanding of how those rules apply to wiring systems which he may be called upon to inspect. He should be provided with and understand the use of an adequate test set. In order to keep posted on the rules he should have a copy of the latest edition of the National Electrical Code and the list of approved materials, appliances and devices listed by Underwriters' Laboratories, Inc. There are numerous handbooks explaining the National Electrical Code and wiring methods. Among these are: Arthur L. Abbott's Handbook published by 1937-1943 McGraw Hill Company and Audels Handbook of Practical Electricity, by Theo. Audel and Co., 49 W. 23rd Street, New York City.

For the prospective inspector the following is a list of questions which should be of assistance in studying the Code in preparation for an examination. These questions or similar questions will be given in your examination:

Q. By whom is electrical material approved?

A. By the authority enforcing the code. (Art. 1.)

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Q. How may approved devices in general be recognized?

A. Usually by a label or manufacturer's number or mark on the device and checking with listings of Underwriters' Laboratories, Inc.

Q. What is meant by voltage "drop" and how is it calculated?

A. Voltage drop is the loss in voltage between the point of supply and the load

$$\text{Drop} = \frac{I \times L (1 \text{ way}) \times 21.6}{\text{Cir. Mils}}$$

Q. What is a "circular mil"?

A. A unit of measure of wire size.

Q. What is meant by "polarity"?

A. Opposite. Usually the difference between hot and grounded circuit wire, or between two separate hot phase wires.

Q. Define a "volt".

A. Unit of electrical pressure. (Also noted as potential.)

Q. A yard light which is controlled from the barn, garage, and back porch, has what kind of switches?

A. 2 - 3 way and 1 - 4 way.

Q. Define (a) "Watt," (b) "Kilowatt".

A. (a) Unit of electrical power, or rate of work.
(b) Represents 1,000 watts.

Q. What is meant by an "overcurrent protective device"?

A. A fuse or circuit-breaker.

Q. An adequate ground at the house has a maximum resistance of how much?

A. 25 - OHMS (2584)

Q. What is meant by "special permission"?

A. The written consent of the authorities enforcing the Code.

Q. What is meant by the term "accessible"?

A. Not permanently closed in by the structure or finish of a building.

Q. What is meant by a "disconnect switch"?

A. A switch which disconnects a circuit from its source of current supply.

Q. What is meant by an "appliance"?

A. A current consuming equipment, fixed or portable. (Heating, cooking or small motor-operated equipment.)

Q. What is meant by "enclosed"?

A. Surrounded by a case so that persons may not accidentally contact live parts.

Q. What is meant by "weatherproof"?

A. So constructed or protected that exposure to the weather will not interfere with its successful operation.

Q. What particular form of electrical contact is prohibited by the Code for terminal connections?

A. Set screw type which damages the wire. (Sec. 1117.)

Q. What is the only stranded conductor approved for connection without solder or lugs?

A. No. 10 or smaller. (Sec. 1117)

Q. For what size of wire are lugs required?

A. No. 6 or larger.

Q. Is it necessary to solder all joints in wires? Why?

A. Yes, unless spliced with approved device. To insure good electrical connection and offset corrosion (Sec. 1118)

Q. Describe in detail any one form of approved splicing device.

A. A threaded metal cap with outer insulation which covers all uninsulated parts of wire and sleeve.

Q. How would you support wires on the outside running from building to building? What clearance should these wires have from the ground?

A. (a) On insulators or racks approved for the purpose. (Sec. 7321-A.)
(b) Over driveways, 18 feet; over lots, 12 feet. (Sec. 7323-a-b)

Q. What clearance is required for wires passing over the roof of a building?

A. Eight (8) feet. (Sec. 7324a)

Q. Does lead-sheathed cable require protection from mechanical injury when buried in the ground?

A. Yes. (Sections 2311; 2313, 2555, 3019.

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- Q. Is the neutral or grounded conductor of the service required to have an insulating covering?
- A. No. (Sec. 2303).
- Q. What is the smallest sized main service entrance conductor permitted on cooperative systems?
- A. No. 8 (See Wiring Specifications AL-23R).
- Q. What special precautions must be taken where conductors enter a building through porcelain tubes?
- A. Tubes must slant inward and upward, also drip loops must be formed on wires. (Sec. 2335).
- Q. What are the specifications for the location of a service switch?
- A. Must be located at nearest readily accessible point to where wires enter building. (Sec. 2351).
- Q. When and how may a service switch open the neutral conductor?
- A. By opening hot wires at the same time. (Sec. 2353).
- Q. Why are unfused service wires and fused circuit wires not allowed in the same conduit?
- A. In the event of a short between circuit wires and service wires there would be no protection for circuits. (Sec. 2306).
- Q. Under what conditions, if any, is it permissible to install weatherproof wire inside of buildings?
- A. Only by special permission. (Sec. 3102).
- Q. What kinds of wiring systems or wire must be used in wet locations in buildings?
- A. Types RL; RW and AVL. (Sec. 3102.)
- Q. Name all the wiring methods recognized by the Code.
- A. Open work; concealed knob and tube work; armored cable; non-metallic sheathed cable; conduit; electrical metallic tubing; etc. (Arts. 300-374).
- Q. Describe the "identified wire" system and explain how it is carried out in a wiring installation.
- A. Grounded conductors are marked by white insulating covering. Hot wires, black, red etc., white wire connected to shell of all sockets. No single pole switches in white wire. (Art. 200).
- Q. In what wire of a branch circuit should switches be placed?
- A. Ungrounded wire.

- Q. What separation between wires is required for wires (a) run open on porcelain cleats? (b) For wires in concealed knob and tube work?
- A. (a) $2\frac{1}{2}$ inches. (Sec. 3205). (b) 3 inches (Sec. 3245).
- Q. What special precautions are necessary where flexible tubing or loom is used to bush wires entering a cut out box or outlet box?
- A. Flexible tubing shall be securely fastened to the box and extend to the next knob or support.
- Q. What is meant by a concealed knob and tube system of wiring?
- A. Where wires are concealed after being run through tubes and on knobs. (Art. 324).
- Q. What size conduit is required for 3-#6 wires in service run?
- A. 1 inch if less than 50 feet and not more than 2 quarter bends. (Footnote table 4).
- Q. How should conduit be connected to outlet boxes exposed to weather?
- A. With threaded connection. Boxes of knockout type should not be used.
- Q. Why must all wires of an alternating current circuit be installed in the same conduit or metal raceway?
- A. To prevent heating from induction.
- Q. How many bends are permitted in an ordinary run of conduit.
- A. Equal of 4 quarter bends. (Sec. 3471)
- Q. What is the purpose of a conduit bushing?
- A. To protect the insulation of wire. (Sec. 3467 & 3468).
- Q. How many No. 14 Rubber covered wires may be installed in a $\frac{1}{2}$ " conduit?
- A. Four (4). (Table 4).
- Q. In concealed or conduit installations how much free conductor should be left at outlets?
- A. At least 6 inches. (Sec. 3006)
- Q. When conduit circuits are run underground what kind of insulation should be used on the wires?
- A. Lead-clad rubber covered TW or type RW (Sec. 3102-6).
- Q. Is there a limit to the number of wires permitted in any one conduit?
- A. Yes, usually nine (Tables 4 to 11).

Q. May wires be spliced in conduit or metal raceways?

A. No. (Sec. 3427).

Q. What precautions are necessary where armored cable (BX is used in wet places?

A. Cable must contain Rubber covered lead sheathed conductors. (Sec. 3342).

Q. Describe the method of splicing two pieces of armored Cable (BX) together

A. Such splices must be made in outlet or junction box. (Sec. 3007)

Q. Under what conditions may outlet boxes be omitted?

A. At switch outlet and tap points of open wiring. (Sec. 3369 and 3703)

Q. What should be done with unused open knock-outs or openings in outlet, junction of switch boxes?

A. They shall be plugged. (Sec. 3712).

Q. May junction boxes be installed in concealed spaces? Explain fully.

A. Not unless the cover is accessible without removing part of building structure. (Sec. 3719).

Q. When testing for insulation resistance should snap switches be "on" or "off"?

A. On

Q. Give the current carrying capacity of the following sizes of Type R wire: No. 14; No. 10; No. 8; No. 6; No. 4.

A. 15A, 30A, 40A, 55A, 70A (Table 1, 1947 Code).

Q. Should the neutral wire of a three wire grounded system be the same size as the other two wires? Why?

A. Yes. Because it must carry the maximum unbalanced load.

Q. What is the maximum voltage permitted on the ordinary rubber-covered wires?

A. 600 volts.

Q. How may rubber-covered wire be identified as to its maker?

A. By tracer threads in or under braid and reference to Underwriters Lab.

Q. What is the underwriter's knot? When is it used?

A. A type of knot used in flexible cords at outlets and sockets to relieve strain on joints.

Q. What is the smallest size of flexible cord permitted?

A. Two conductor No. 18.

Q. Is rubber-covered wire permitted for wiring of fixtures?

A. Yes, if temperature involved does not exceed 122° F. (Sec. 4144)

Q. What is an electric cabinet?

A. An enclosure for either flush or surface mounting, having trim and swinging doors.

Q. What is a cut out box?

A. Same as cabinet, except door, telescopes box and has no trim.

Q. What depth of outlet box is ordinarily required by the Code?

A. One and one-half ($1\frac{1}{2}$) inches. (Sec. 3706)

Q. When a canopy or pan type fixture is installed on an outlet box in a wooden ceiling what precautions should be taken?

A. The combustible surface between fixture pan and outlet box must be covered with an incombustible material. (Sec. 4124).

Q. Are Edison base plug fuses permitted on 230-volt, 3-phase motor circuits?

A. No. (Sec. 2451 & 2453).

Q. What is the distinguishing mark on face of 15 ampere plug fuses?

A. Hexagonal or 6-sided window or recess, in addition to Underwriter's label.

Q. How high above the floor would you place fuse cabinets under ordinary conditions?

A. Not more than 6 nor less than 4 feet.

Q. Is an automatic circuit-breaker accepted as a switch?

A. Yes. (Section 2351-a).

Q. Under what conditions may a motor circuit be connected to a larger feeder without a fuse at the point of change?

A. Motor circuit wire must have at least $\frac{1}{3}$ the capacity of main feeder, or the circuit wires to motor protective device and should not be more than 25' long. (Sec. 4348).

Q. What is the largest motor that may be connected to a lighting branch circuit?

A. $\frac{1}{4}$ H.P.

- Q. How would you determine the size of fuse on a conductor supplying a group of motors?
- A. Use starting current of largest motor plus running current of all other motors. (Tables 26, 27, 22, 23 or 24) (Sec. 4343-6).
- Q. Are automatic over-current devices required in the grounded conductor of a circuit?
- A. No.
- Q. What percentage of the full load current rating of a motor must be provided in the carrying capacity of the mains?
- A. 125%. (Sec. 4312)
- Q. What is the minimum size of pipe which may be used for an artificial ground electrode?
- A. 3/4". (Sec. 2583-b-c.)
- Q. Does the Code require driven grounds to be galvanized?
- A. Yes, if steel pipe or rod. (Sec. 2583-b-c.)
- Q. What is the smallest wire permitted for grounding service entrance and equipment?
- A. REA specifies No. 6.
- Q. What is the smallest wire permitted for a separate ground on interior conduit?
- A. No. 14 for 30 ampere equipment. (Sec. 2595).
- Q. What is the purpose of grounding one conductor or neutral of service entrance?
- A. Circuits are grounded for the purpose of limiting the voltage when exposed to lightning, etc. (Sec. 2511.)
- Q. What is the purpose of grounding metal enclosures for wires, such as conduit?
- A. To prevent, if possible, any flow of current on the equipment which might cause personal injury.
- Q. At what point of a conduit system should the ground wire be connected?
- A. At the service. (Sec. 2523).
- Q. Does the wire which grounds the system at the service have to be insulated?
- A. No. (Sec. 2591).

Q. What is the maximum resistance to ground permitted for (a) water pipe ground; (b) driven ground?

A. (a) 25 OHMS (usually has 3 OHMS); (b) 25 OHMS. (Sec. 2594).

Q. Must frames of all motors be grounded?

A. Yes, unless insulated, isolated or guarded. (Sec. 4435).

Q. Where should a motor starting switch be located with regards to the motor?

A. In sight of the motor. (Sec. 4386).

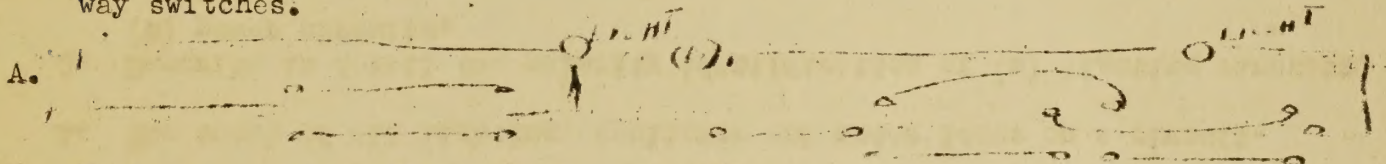
Q. How does an isolating switch differ from a general use switch?

A. The one isolates circuit after load is disconnected by other means. The other is capable of interrupting its rated current at rated voltage. (Article 100-Definitions).

Q. Does a motor controller have to disconnect all ungrounded wires to the motor?

A. Only when it serves also as a disconnecting means. (Sec. 4384).

Q. Draw a diagram showing the connections of (a) three way switches; (b) four way switches.



Q. What is an externally operable switch?

A. One capable of being operated without opening the door.

Q. Describe a weatherproof socket?

A. Outer jacket is of weatherproof materials and sealed around wires so as to exclude moisture.

Q. What type of wire is required for the wiring of indoor lighting fixtures.?

A. Usually type AF or CF (Sec. 4144).

Q. Why are key sockets prohibited over specially inflammable material?

A. Arcs may cause fire. (Sec. 4113).

Q. Where are weatherproof sockets required?

A. In damp or wet locations. (Sec. 4111)

Q. On a fixture containing several sockets, how should the identified conductor be connected?

A. Connect to all identified fixture wires and each of these to screw shell of socket.

Q. Explain in detail the complete installation for an electric range.

A. Install service with range circuit, run 3 No. 6 cable to range receptacle, ground range frame to the grounded neutral.

Q. May wall receptacles be installed in the floor?

A. Not unless in floor boxes approved for the purpose. (Sec. 4162).

Q. What is meant by a branch circuit?

A. Any wiring circuit extending beyond the final overcurrent protection. (Article 100-Definitions).

Q. What is maximum size fuse permitted on the ordinary branch lighting circuit?

A. 15 amperes.

Q. What is meant by the term "connected load"?

A. The total of all lighting, appliance and motor loads on a circuit.

Q. Describe in detail the polarity identification of (a) lighting circuits; (b) power circuits.

A. (a) White wire grounded, connect to shell of all sockets. Other wires fused and run through switches to center contacts. (b) 3-phase power circuits have no white wire. (Art. 200 and Sec. 2104).

Q. Describe the different types of branch circuits recognized by the Code.

A. 15-A; 20-A; 30-A and 50-A circuits. (Art. 210 and Sec. 2126).

Q. Describe in detail a portable extension lamp for use in a garage or in damp locations?

A. Connect with attachment plug through reinforced rubber cord, use non-metal socket and lamp guard. No switch on socket. (Sections 4172, 5104, 5107 and 5108.)

Q. What special precautions should be taken in connection with emergency or exit lighting circuits in a school auditorium or in a theater?

A. Connection of emergency lighting circuit shall be independent of main fuses and/or separate supply provided. (Sec. 5202 and 7011).

1. What size feeder, switch, fuses and motor branch circuit would be required for a 3/4 h.p. pump motor located 200 feet distant from the main service?

From Table 22, page 321:

The full load current rating of a 3/4 h.p. motor is 9.4 amperes at 110 volts and 4.7 amperes at 220 volts.

Using the formula:

$$\frac{\text{Volts Drop} - I \times L \text{ (1 way)} \times 21.6}{\text{Circular Mils}}$$

where I - current, or 9.4 amperes

L - distance (1 way) - 200 feet

Circular Mils - Cross section area of conductor and the present unknown.

Using a voltage drop of not more than 3 per cent (Section 2202, page 37):

$$\text{Voltage Drop} - 3\% \times 115 \text{ volts} - 3.5 \text{ volts.}$$

Rearranging the above formula:

$$\frac{I \times L \text{ (1 way)} \times 21.6}{\text{Cir. Mils} - \text{Voltage Drop}}$$

$$\frac{9.4 \times 200 \times 21.6}{3.5} = 11,600.2$$

Using the same formula the result for 230-volt circuit the circular mils - 2,942.6

From Table 18:

We note the next larger size conductor above 11,600 C.M. is 16,510 C.M. which requires a No. 8 conductor on 115-volt, 2-wire feeder. Similarly a No. 12 conductor would be sufficient on 230-volt, 2-wire circuit. However, the supports for No. 12 must not be more than 35 feet apart under REA requirements. (See AL-23R).

From Section 4312, page 147.

The conductors supplying a motor must have a current capacity of 125% of the motor nameplate rating. Thus:

$$125\% \times 9.4 \text{ amperes} - 11.8 \text{ amperes.}$$

From Table 20, Page 329

The minimum size motor circuit conductor would be No. 14; from column 8, table 20, the overcurrent protection required is a maximum of 15 amperes. This requires a 30 ampere switch with 15 ampere fuse, or a 15 ampere circuit-breaker.

2. How many and what size branch circuits; and what size service conductors and equipment are required for a dwelling 40 feet by 40 feet, having also an 8 KW range?

40' x 40' - 1,600 Square Feet
Computed Load - (Section 2116):

General Lighting Load:

1,600 Square feet at 2 watts per square foot	- 3,200 watts
Small appliance load	- 1,500 "
Special appliance load (1-20 ampere, 2-wire No. 12 required for this circuit)	- 1,500 "
Total computed load	6,200 watts
Less special appliance circuit	
Total load for calculating circuits	- 1,500 watts
	4,700 watts

Minimum Number of Branch Circuits required - (Section 2115):

General Lighting Load:

4,700 - 115 - 41 amperes
41 --- 15 - 3 - 15 ampere, 2-wire circuits. (This is in
addition to the 20 ampere, 2-wire No. 12 special
appliance circuit mentioned above.)

Range Circuit - (See Table 29, page 338):

8 KW - 8,000 watts
8,000 x 80% - 6,400 watts
6,400 - 230 - 27 amperes or one 50 ampere, 3-wire circuit
(Code requirements would permit the
use of 3-wire No. 8 for this
circuit. However, REA specifica-
tions AL-23R call for 3-wire No.
6.)

Minimum Size Feeders (or Service Conductors) Required -
(Section 2101 and 2203):

Total Computed Load - 6,200 watts

2,500 watts at 100%	-	2,500 watts
3,700 watts at 30%		1,110 watts
Net computed load		
(without range) -		3,610 watts
Range load - 8,000 x 80%		6,400 watts
Net equipment load (with range) -		10,010 watts

For 115/230 volt, 3-wire system (with range):
10,010 - 230 - 43.5 amperes

From Table No. 1 , page 316

We find this dwelling to require a 3-wire No. 6, 45 ampere service.